WinDS – Wind Deployment Systems Model

An Update

3rd Renewable Energy Modeling Summit

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Presentation Contents

- A Brief Review
- Preliminary Results
- Future Efforts

WinDS Model

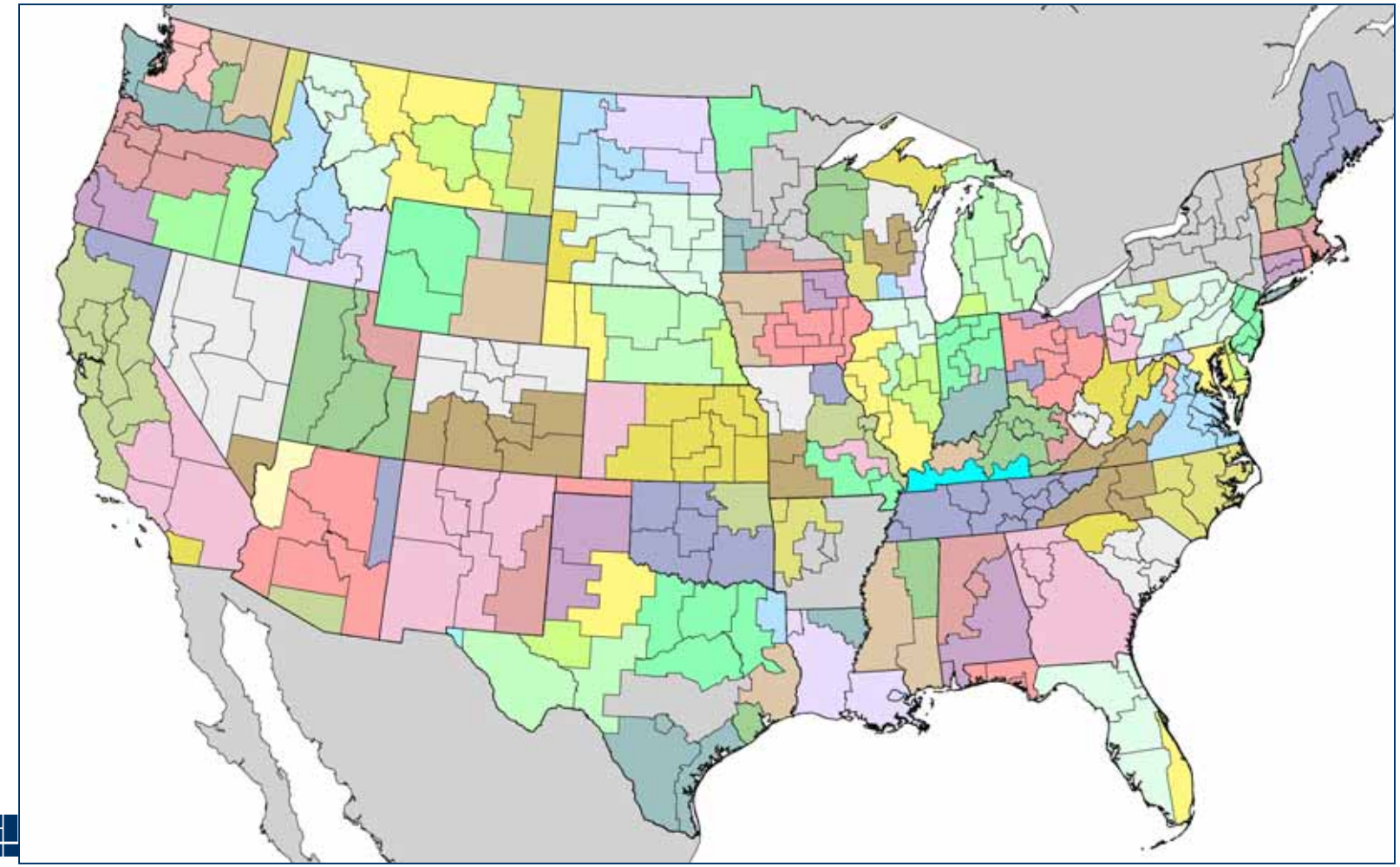
- A multi-regional, multi-time-period model of capacity expansion in the electric sector of the U.S.
- Designed to address the principal market issues related to wind energy
  - Transmission
  - Intermittency
  - Site access

General Characteristics of WinDS

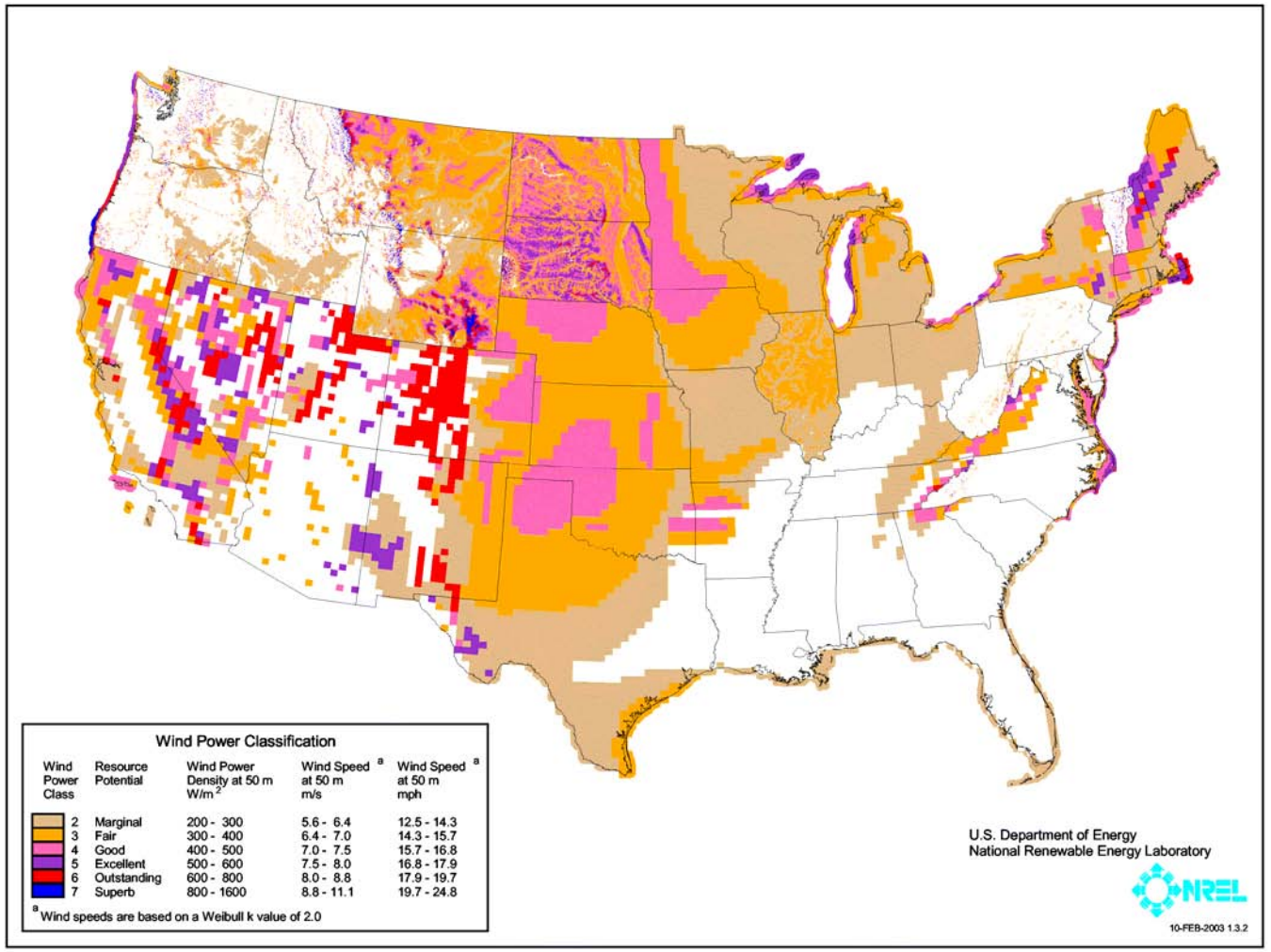
- Linear program optimization for each of 25 two-year periods from 2000 to 2050
- Minimizes system-wide cost of meeting loads, reserve requirements, and emission constraints
- Other generation technologies – hydro, gas CT, gas CC, 4 coal technologies, nuclear, gas/oil steam, geothermal, biomass, solar thermal, other
- 4 levels of regions – wind supply/demand, power control areas, NERC areas, Interconnection areas
- Sixteen time slices in each year: 4 daily and 4 seasons
- 4 wind classes (3-6), wind on existing AC lines and wind on new transmission lines

WinDS Regions

WinDS PCA and Demand Regions



Updated Wind Resources with Fewer Land-Use Exclusions



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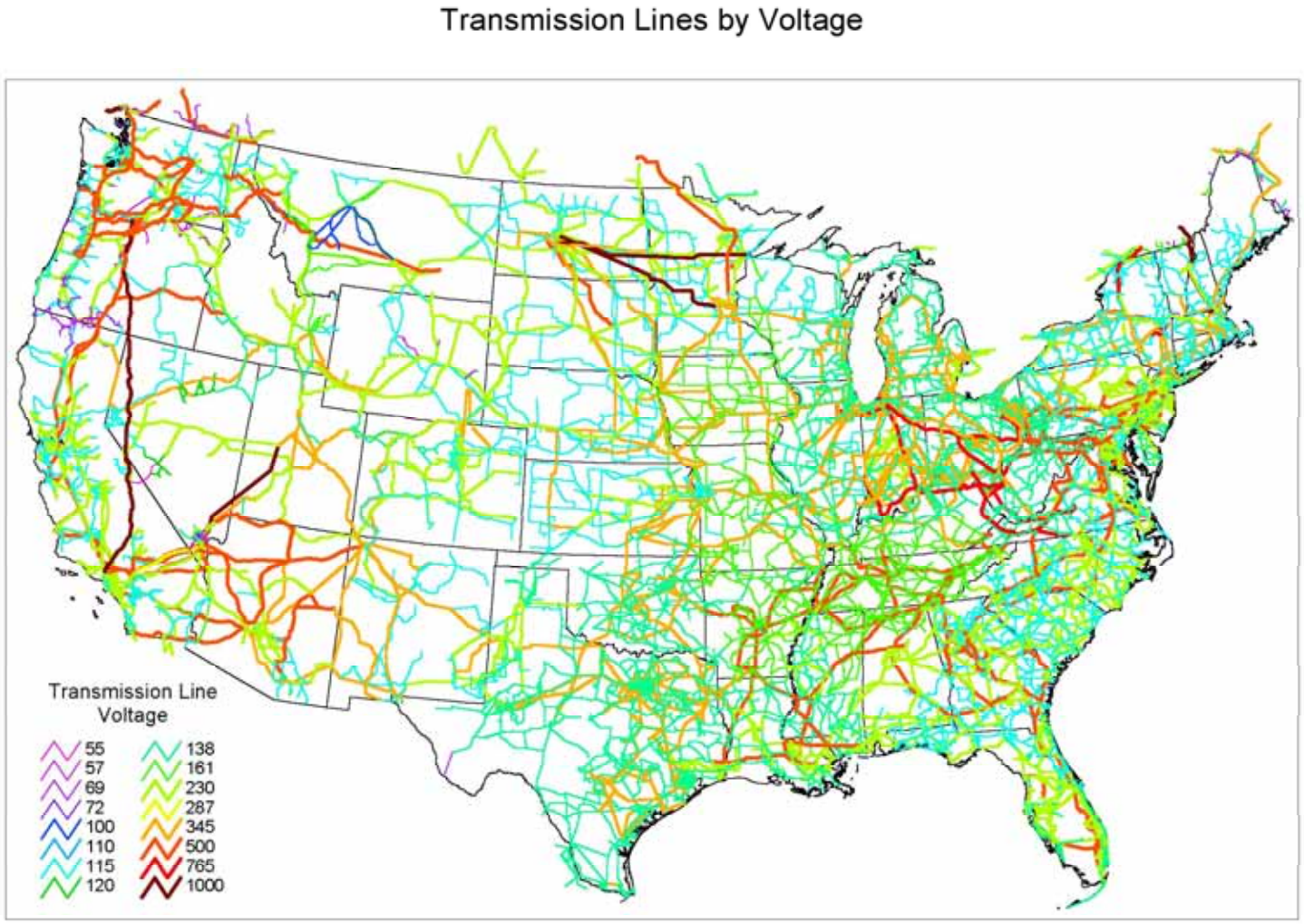
Transmission in WinDS



Unique WinDS Constraints

- Transmission
  - Cost to build to existing lines
  - Capacity of existing lines
  - Bottlenecks on existing lines
    - New line builds to remove bottlenecks
  - Builds of wind-dedicated new lines

Unique WinDS Constraints (Cont'd)

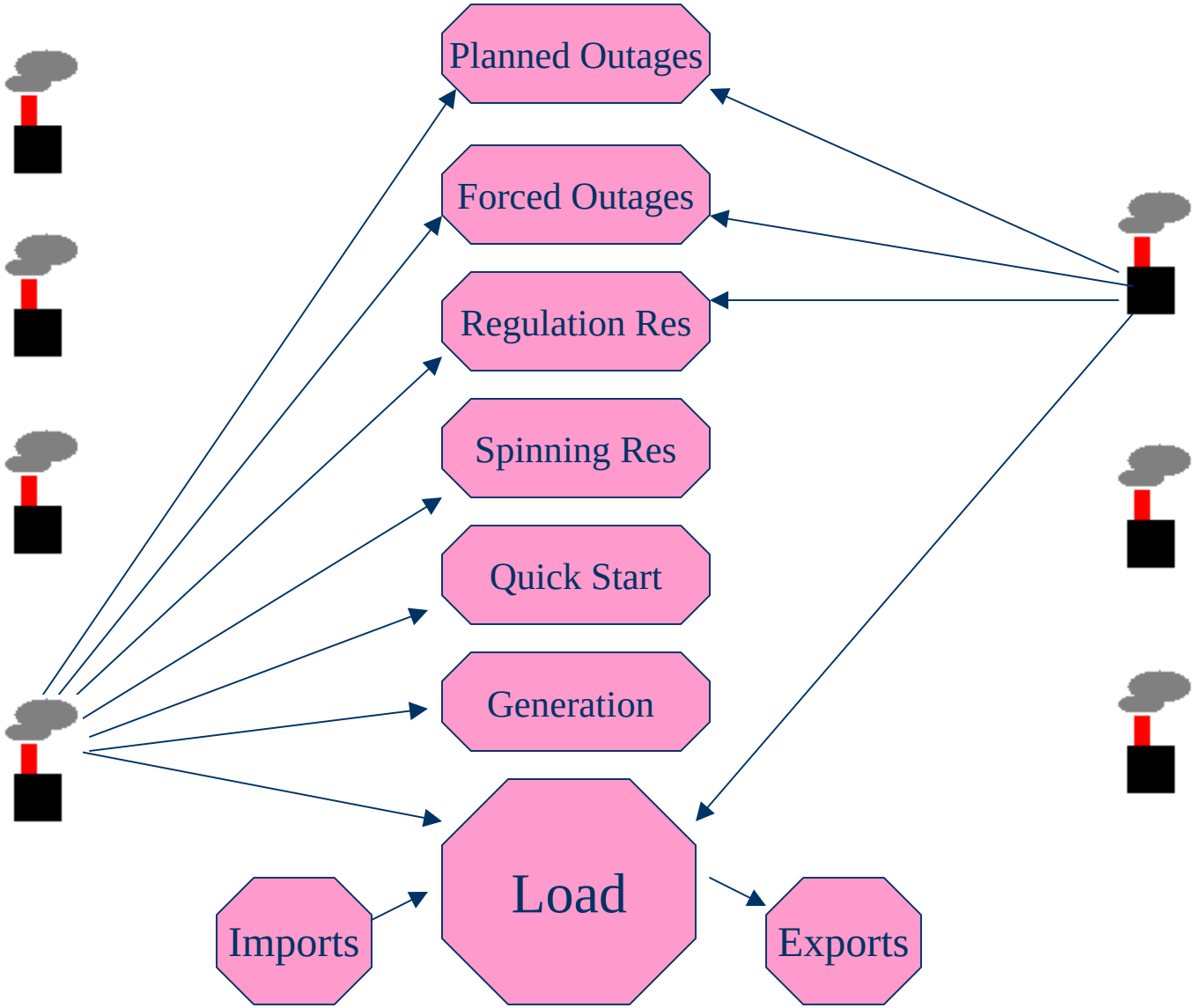
- Intermittency – stochastic determination of:
  - Reserve margin contribution
  - Wind-induced operating reserve requirement
  - Wind-induced regulation reserve requirement*
  - Surplus wind
- Site Access –
  - Moderate environmental and land-use exclusions
  - System* and transmission cost as a function of regional terrain slope
  - Transmission cost as a function of population density

* Under development

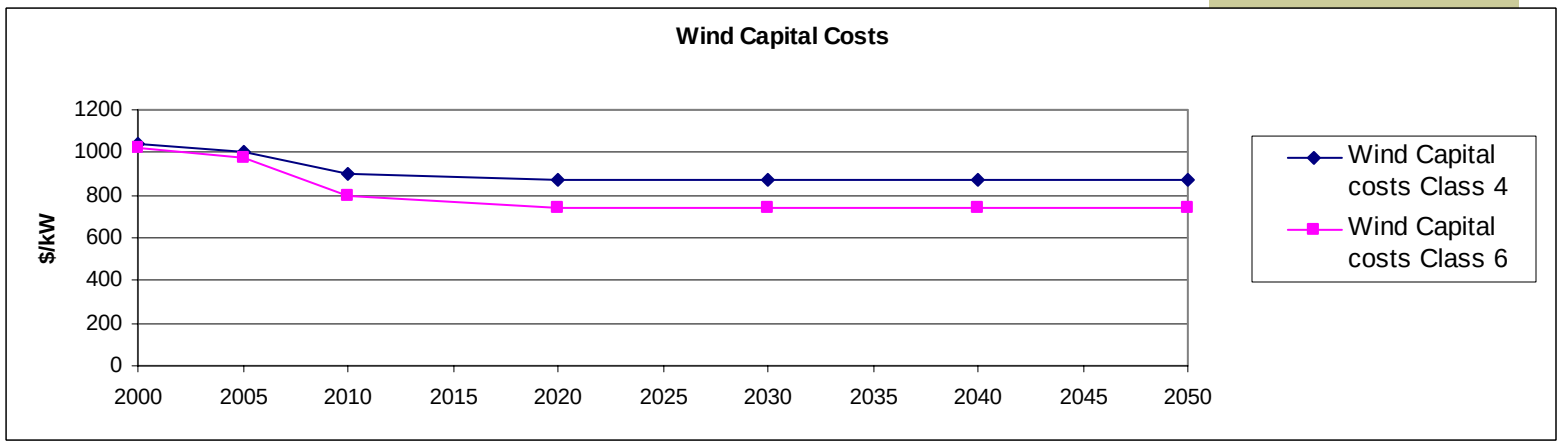
Wind Energy Costs

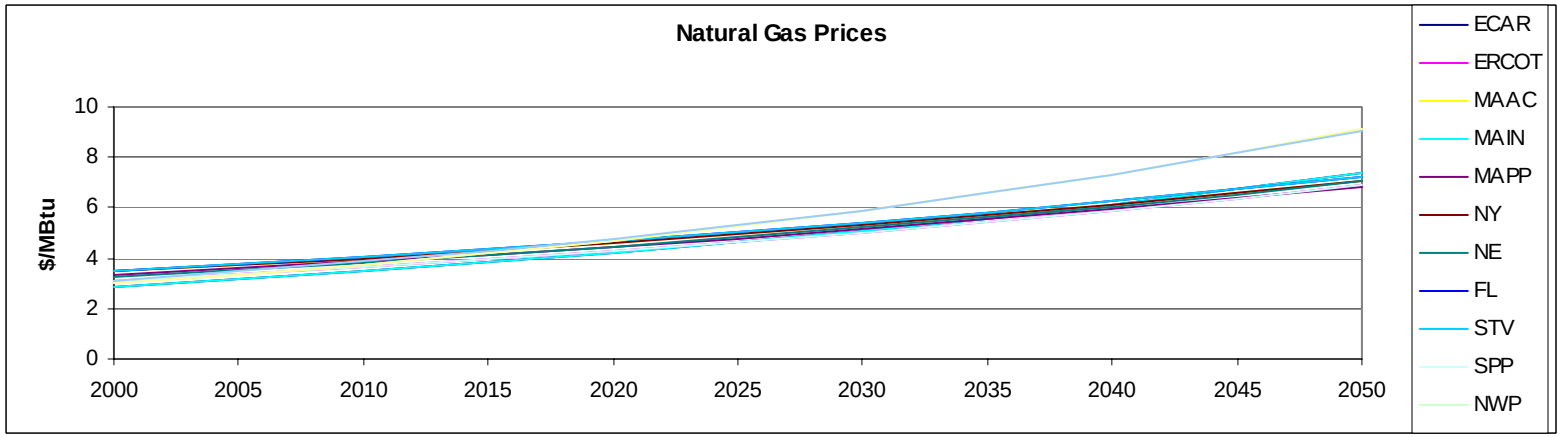
- Capital costs, operating costs, and capacity factors can vary
  - by wind class
  - Over time according to user inputs
  - Capital costs can decrease with learning
  - PTC or ITC with start/stop dates, term, rate
- Price penalty on capital costs for rapid national growth
- Financing explicitly accounted for
  - Corporate or project-specific
    - Project specific optimizes debt fraction to meet DSCR
- Transmission costs
  - Existing lines: $/kWh/mile;
  - New lines: $/kW/mile

Conventional Technology Constraints

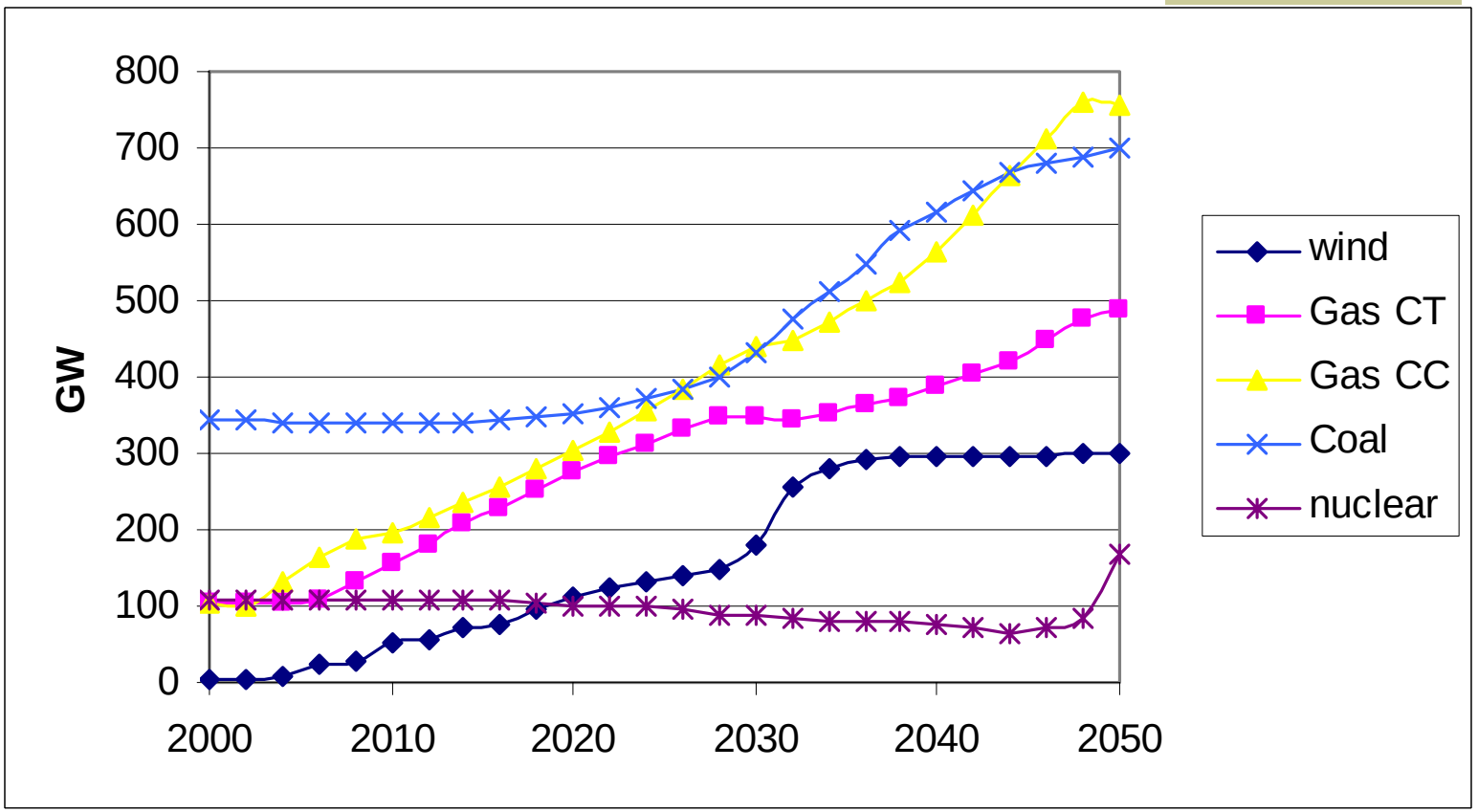


Preliminary Base Case
Primary Inputs

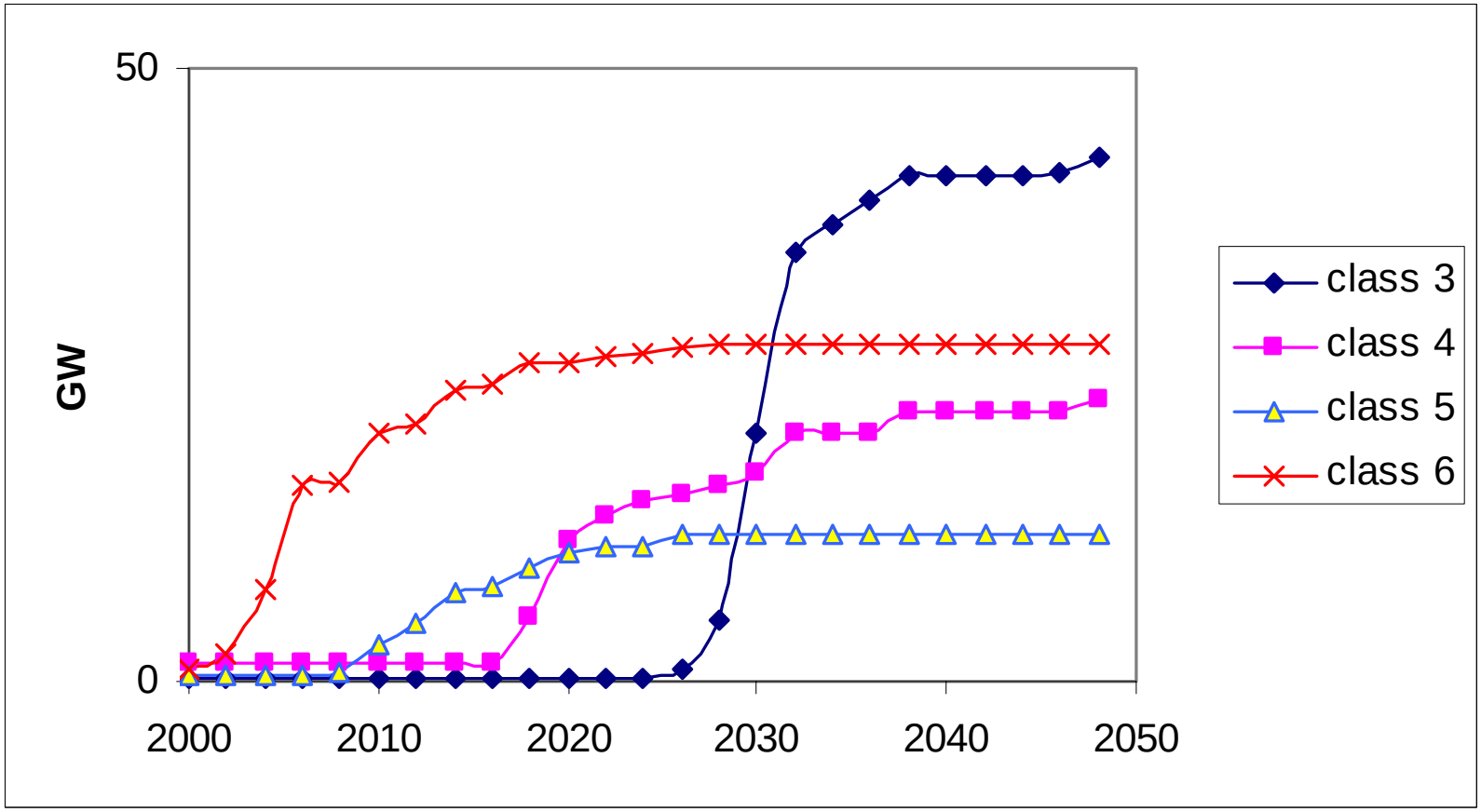




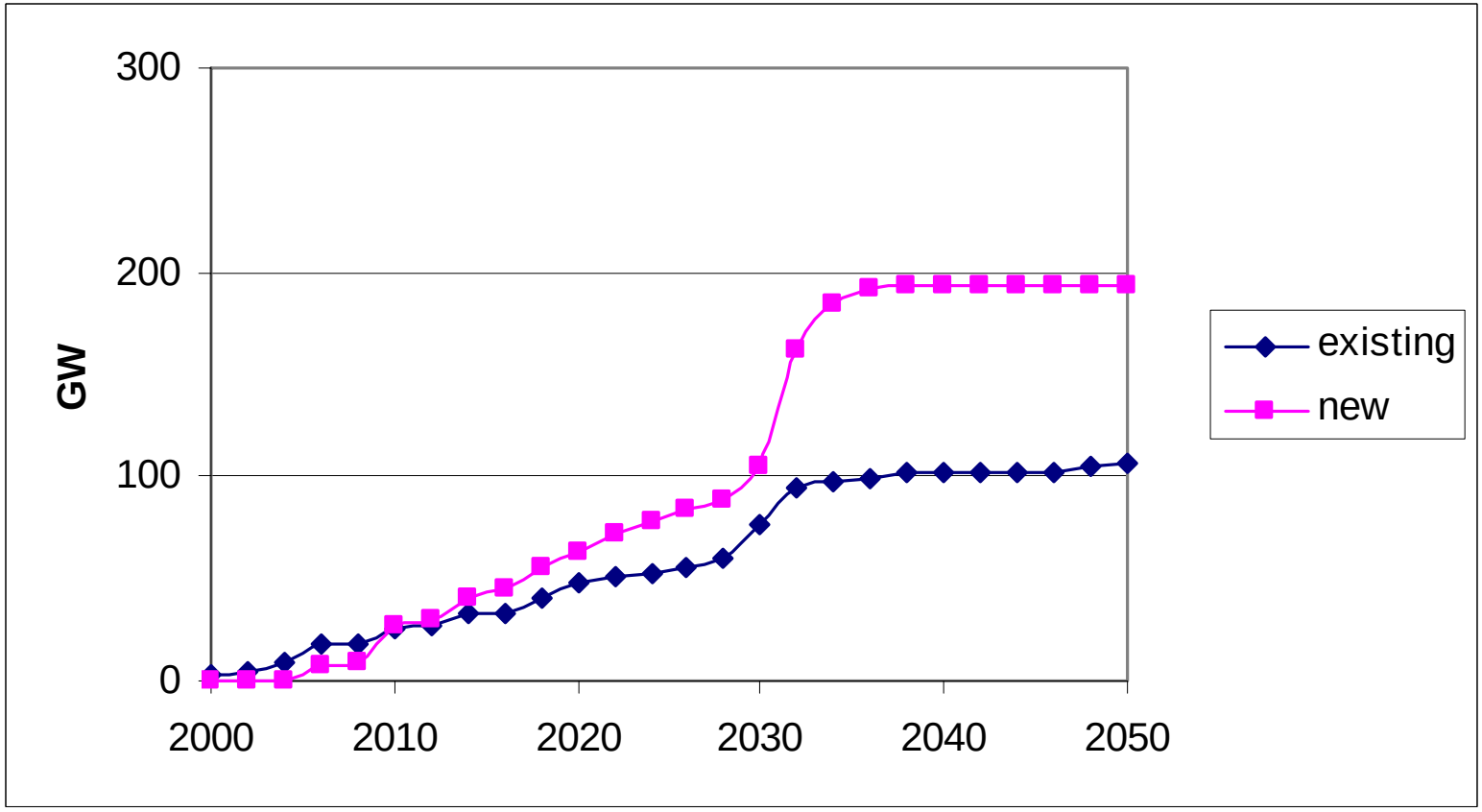
Preliminary Base Case Results
Capacity



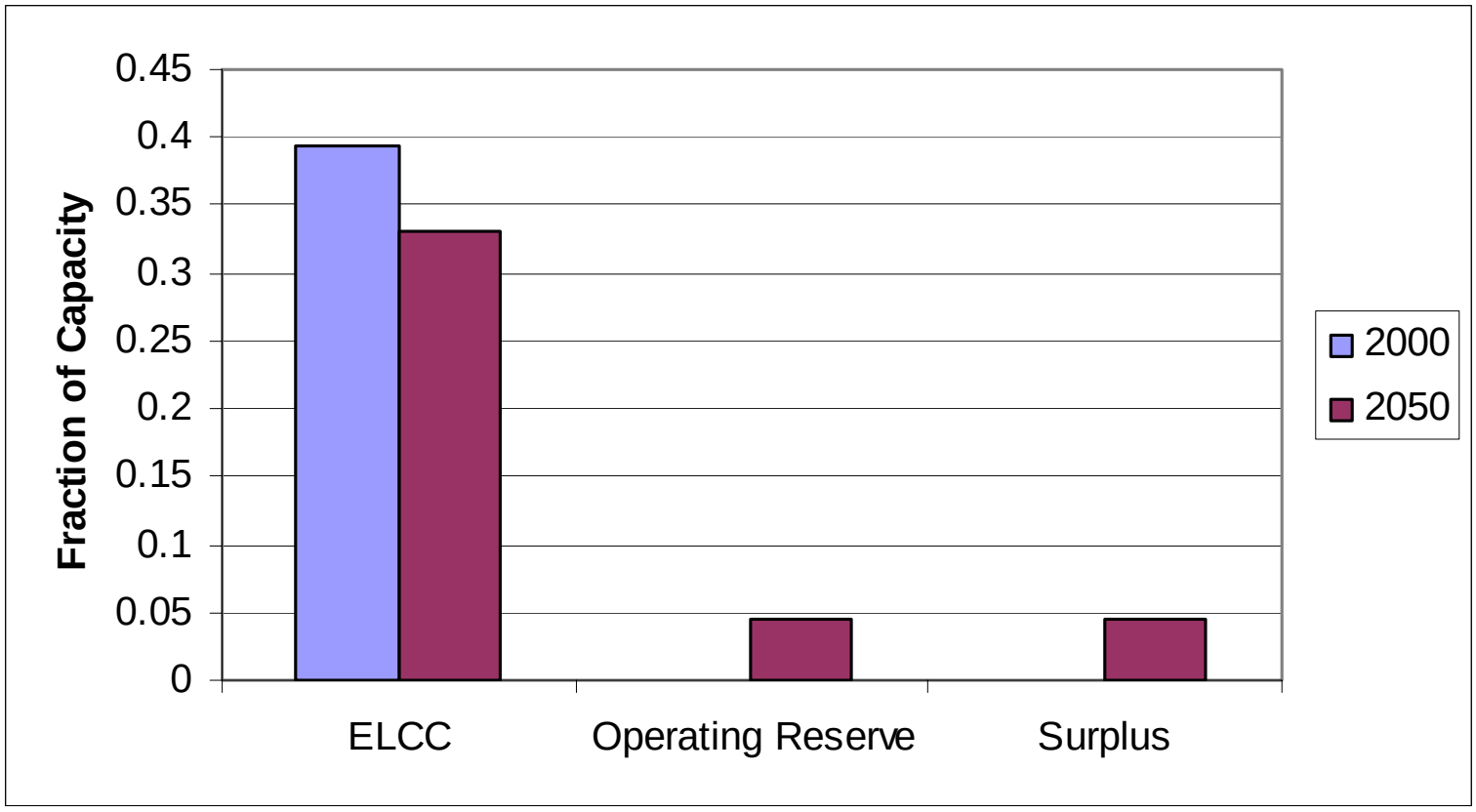
Preliminary Base Case Results
Capacity by Wind Class



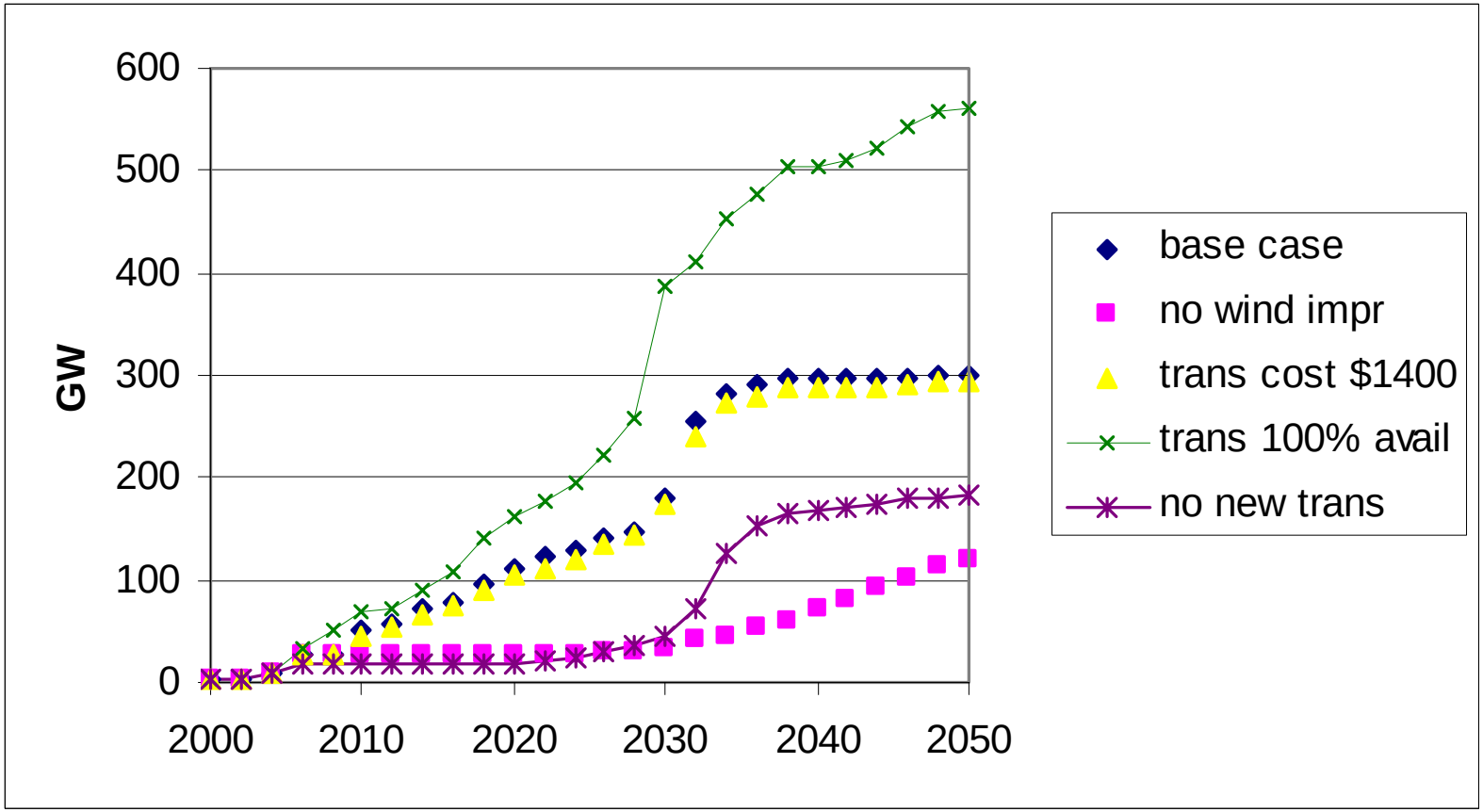
Preliminary Base Case Results
Capacity by Transmission Vintage



Preliminary Base Case Results
Reserve Requirements in Texas



Preliminary Sensitivities
Capacity



Next Steps with WinDS

- Refine the model
- Conduct analyses of principal market issues for wind
- Transfer the findings to other more general energy market models such as MARKAL, NEMS, IPM, etc.
- Add H2 storage/generation and fuels